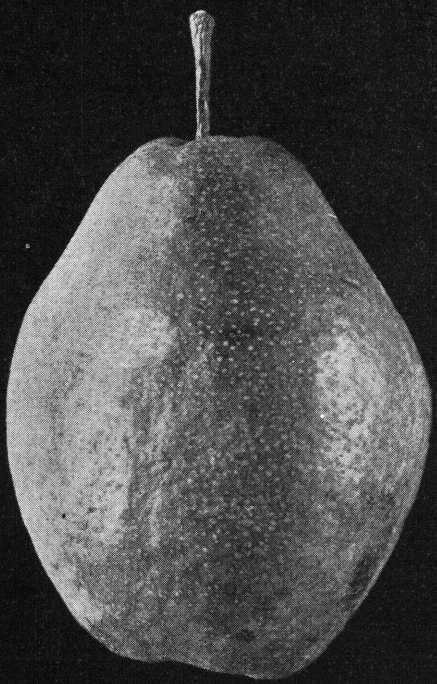
HANDLING AND PREPARING THE KIEFFER PEAR FOR USE AS FOOD



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THE KIEFFER PEAR can be effectively used by adopting special methods of handling which develop the soft texture and pleasing flavor desirable in the fresh condition and by employing special methods of preparation in cooking, canning, and preserving.

When the fruit is properly ripened and suitable methods of preparation are employed a satisfactory canned or dried product can be obtained.

The optimum quality is developed in the fruit by storing it after harvest at a temperature of 60° F. This is known as the ripening process, and the time necessary for the ripening to take place varies with the stage of maturity of the fruit when harvested.

After harvest, the fruit may be stored at 32° F. for a limited period of 2 to 4 months during which time little apparent change takes place. However, if the fruit is placed in a ripening room at 60° after storage at 32° it requires a shorter time to ripen than it would if ripened immediately after harvest.

Although the stone cells are not destroyed during ripening, they do become much less objectionable. In the preparation for canning, preserving, or drying, it is advantageous to core the fruit deeply enough to remove the more conspicuous clusters of stone cells located near the core.

The storage life of the fresh fruit particularly after ripening, is short. Therefore, in order to use any very large quantity it is necessary to preserve the material in some way.

Decay organisms readily attack and destroy wounded fruit and every precaution should be taken to prevent injury, and as far as possible to prevent the organisms coming in contact with the fruit.

Washington, D. C. Issued February 1938

HANDLING AND PREPARING THE KIEFFER PEAR FOR USE AS FOOD

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CONTENTS

NEED FOR BETTER PRACTICES IN USING THE FRUIT

THE ORIGINAL TREE of the Kieffer pear was grown by Peter Kieffer near Philadelphia, Pa.; it fruited first in 1863 and soon became widely distributed. For a number of years the Kieffer pear has been more generally grown throughout the United States than any other variety, except in the intensively cultivated commercial districts, such as those in Washington, Oregon, California, and western New York.

The tree is vigorous, very productive, and more resistant to blight and insect attack than most varieties, which accounts for its predominance in farm and home orchards. In the East it has survived where most other varieties have succumbed to the ravages of pear blight.

The fruit is large and attractive and is rather resistant to many of the fungi and insects that attack other pomaceous fruits. However, the fruit has acquired a reputation of being very poor in quality and for this reason is considered by many to be almost worthless. When freshly picked from the tree, the fruit is hard, coarse, and, therefore, rather inferior to many European varieties in texture. The stone cells are more in evidence than in many varieties, and it is lacking in the characteristic pear flavor. It never ripens on the tree to the soft texture that is desirable in fresh fruit, though in some localities the green color more or less disappears, and the skin becomes yellowish, which gives it the appearance of being ripe. Even when cooked, it generally does not soften to a product entirely satisfactory in texture. The necessity for proper storage, in order to soften or ripen the fruit, is not always known or appreciated by many who grow the fruit, especially by those who grow it for home use. As a consequence the fruit is often allowed to go to waste, or at least is poorly utilized.

Since approximately 20 percent of the 23 million bushels of pears produced in the United States in 1934 were Kieffer pears and since some districts cannot produce any other variety because of the presence of pear blight, it seems important that the very best methods of handling and using the fruit should be made widely known, in order to secure its fullest possible utilization. This bulletin, therefore, pre-

sents available information in regard to handling the fruit so as to obtain the maximum of quality in the fresh fruit and the most desirable preserved products.

Many of the objectionable characteristics of the fruit are to a considerable extent overcome by proper methods of harvesting, followed by correct methods of storage to promote ripening, and finally, by employing suitable methods of preparation for final consumption as food. As a result of 3-years' experimental work conducted by the United States Department of Agriculture with fruit grown in Mississippi, Alabama, Michigan, New York, Maryland, and Virginia, it has been demonstrated that Kieffer pears can be so handled that they will be of much higher quality than they usually have been in the past. The following recommendations are based largely on these studies.

HARVESTING

TIME OF PICKING

The fruit may be harvested at any time between the time it is one-half to two-thirds full size and the time it has reached full size. The quality after ripening is not greatly affected by the stage of maturity when picked, although fruit that has reached only two-thirds full size is not quite so desirable as that picked later. On the other hand, fruit that has remained on the trees until very late in the season is apt to ripen poorly in storage and will be correspondingly less desirable in texture and flavor. Leaving the fruit on the tree too long should be avoided, particularly in the territory south of Washington, D. C. In northern sections, such as Michigan and New York, picking should usually be delayed as long as possible. Growth continues almost as long as the fruit remains on the tree; hence if it is picked too early the yield will be reduced. In some sections if the picking is delayed, considerable loss will occur as a result of dropping. Windstorms are much more disastrous toward the close of the season, when the fruit is large, especially if the branches are strained under a heavy load. The proper time for picking seems to be when maximum yield is obtainable, that is, when increase in size no longer compensates for loss from decay and by dropping. At this stage the green in the immature fruits gradually fades, and the fruit becomes lighter or slightly more yellow.

The pressure tester may also aid in deciding the best time to harvest. Immature fruit will frequently test as high as 15 to 18 pounds with the Magness and Taylor pressure tester, whereas fruit tested late in the season will test as low as 12 pounds. Generally fruit that tests about 13 to 14 pounds will be at about the right stage for harvesting. This varies somewhat with the locality and the seasonal conditions. In using the pressure tester on pears, the firmness of the fruit is determined by measuring the force in pounds required to drive a rounded plunger five-sixteenths of an inch in diameter to a depth of five-sixteenths of an inch in the flesh of an area from which the skin has been removed. The apparatus (fig. 1) consists essentially of a plunger operating against a coiled spring inside a tube, which is provided with a scale from which the pressure required to penetrate the fruit can be read directly in pounds. Ten to twenty fruits should be tested in two or three places each, and the average of all the tests should be taken as the measure of the firmness of the lot of fruit.

METHODS OF PICKING AND HANDLING

Kieffer pear trees tend to grow very tall, and in practice they are not generally pruned so that the fruit can be harvested without the use of ladders; hence the picking of the fruit is an important operation. In harvesting the fruit, care should be taken to prevent its being bruised, as the bruised areas become brown during the ripening period and detract from the appearance of the product when prepared for use. The bruised areas, especially if the skin is broken, provide an entrance for fungi, which cause the fruit to decay. The fruit is often large and heavy, and if it is dropped into the picking basket the skin is apt to be broken and the fruit bruised. The stem is large and stiff and will frequently puncture the skin of another fruit if the fruit is carelessly dropped into the picking container. The customary picking bag is satisfactory if reasonable care is taken in transferring

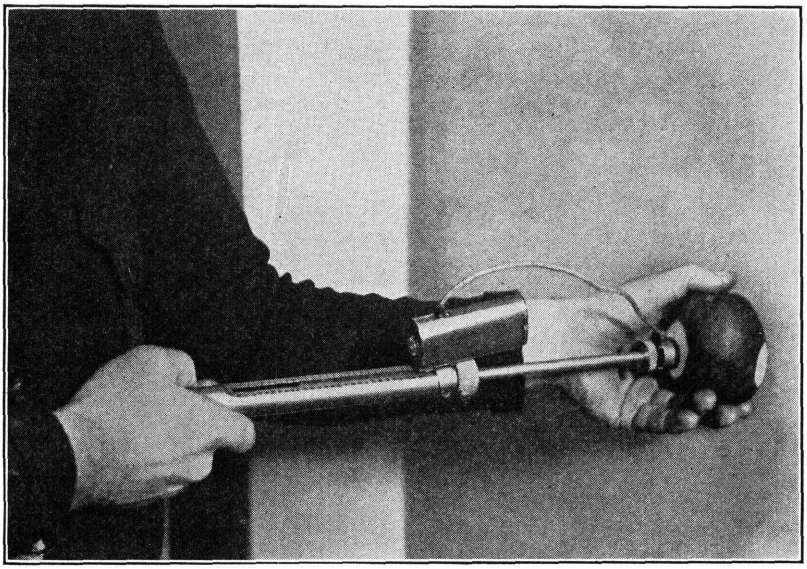

FIGURE 1.—Pressure tester, developed by Magness and Taylor, to indicate firmness of fruit.

the fruit, or the fruit may be transferred from field to storage in bushel baskets if care is exercised in stacking the baskets so that the fruit underneath is not bruised. However, substantially built lug boxes are preferable.

RIPENING

In order to develop the maximum dessert quality in Kieffer pears it is necessary to place the fruit after harvest under the proper storage conditions for a certain length of time, so that it will become soft in texture. This storage period is generally spoken of as the ripening period or ripening process. A rather remarkable feature of the behavior of the fruit is the development of a soft texture and pleasing flavor even in pears that have attained only one-half to two-thirds their normal size, when stored at a temperature of 60° to 65° F. The differences in the behavior of the fruit when stored at different temperatures are rather striking. This is shown very clearly in figure 2.

Here the measure of the firmness of the fruit is the number of pounds registered by the pressure tester (fig. 1).

At a temperature of 80° to 100° F. the fruit softens very little, even when held at this temperature for 20 to 30 days. If the material stored at this temperature is peeled and cooked in the usual way it remains more or less undesirably firm and tough. When stored at a temperature of 70° to 80° the rate of softening increases, and the texture and palatability are correspondingly improved; generally, however, the fruit does not become soft enough to be entirely satisfactory. The rate of softening is at its maximum at 60° to 65°. After 2 to 3 weeks of storage at this temperature the fruit becomes uniformly soft, and the flavor and texture improve, and it becomes

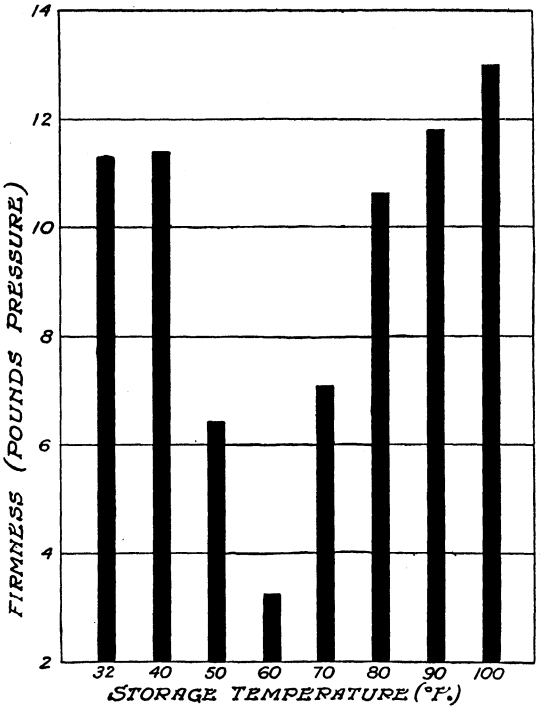

FIGURE 2.—Firmness, or resistance to pressure, in pounds, of Kieffer pears after 20 days' storage at various temperatures between 32° and 100° F.

quite satisfactory for eating fresh as well as for cooking and preserving. At a temperature of 50° the rate of softening is very much slower, but the fruit ultimately ripens to a satisfactory texture for eating. However, in some cases it fails to ripen properly at this temperature. At temperatures below 50° the rate of softening is very much slower, and the fruit never softens to a completely satisfactory texture. At 32° it does not soften to any extent even when stored for several months. When it is cooked after such a storage period it still does not soften sufficiently to be satisfactory, no matter how long the cooking process is continued, but behaves practically as it did when freshly picked from the tree.

The change in the color of the skin during storage at the different temperatures is also very striking. The rate of change of the green color to a yellow is most rapid at 80° F., and the intensity of color finally developed is considerably greater at this temperature than at lower or higher temperatures. At 90° to 100° the green will persist for several days longer than at 80°; at 60° the color changes are somewhat less rapid than at 70° or 80°, but by the time the fruit has softened it will have attained a very attractive yellow color. At 32° the change is extremely slow. Except in exceedingly immature fruit the change of the color of the flesh is of little importance. The color of the flesh is nearly the same irrespective of the storage temperature. In very immature fruit stored at 80° the flesh becomes somewhat deeper yellow than in mature fruit.

During the ripening process the flavor is very greatly improved. Maximum development of flavor occurs at 60° to 65° F. Therefore the development of flavor almost exactly parallels the rate of softening. Both flavor and texture of Kieffer pears ripened in this temperature range are far superior to those ordinarily expected or obtained.

STORING PREVIOUS TO RIPENING

Under some circumstances it may be advantageous to store the fruit for a few months before it is used. If such is the case it is generally best to store it at 32° F., before, rather than after, it has ripened. The firmness of the fruit remains almost unchanged at 32° and when removed to 60° it ripens satisfactorily but at a more rapid rate than fruit that has just been harvested. After storage at 32°, the rate of softening at 60° varies with the length of the storage period. For instance, it requires about three-fourths as long to ripen fruit harvested early in the season and stored for 1 month at 32° as it takes to ripen it when stored at 60° immediately after it is harvested; it requires about two-thirds as long after it has been stored for 60 days at 32°; and one-half to two-thirds as long after 120 days' storage at this temperature. Fruit stored at 32° for 180 days does not ripen as rapidly as that stored for 120 days, or even fails to ripen at all. Quality at this stage is very poor. The failure to ripen properly may occur after 120 days' storage with fruit picked later. It is not advisable, however, to store fruit at 32° for a period longer than 90 days because the quality is inferior and ripening uncertain. In other words, the fruit has about reached the end of its storage life after 90 days at 32°.

However, this gives a limited opportunity to harvest the entire crop at the proper time, store it at 32° F., and ripen it as it is needed for use. This may be particularly advantageous to the commercial canner, as the amount of fruit ripened each day can be limited to the capacity of the canning plant. Storage at temperatures above 32° is not recommended, for internal break-down, or the formation of areas within the fruit in which the flesh is discolored and disintegrated, occurs when the temperature is only a few degrees above 32°. Other changes related to the ripening process may also occur and greatly shorten the storage life of the fruit.

Because of greater loss from decay the opposite procedure may be employed to only a very limited extent; that is, the fruit may be ripened at 60° F. and then stored at 32° for a period of several days. The storage life of the material is not nearly so long with this pro-

cedure, but occasions may arise where the ripened material may be so held until it can be used.

LENGTH OF THE RIPENING PERIOD

The length of the ripening period varies with the temperature (see page 4), the fewest days being required at approximately 60° F. At this temperature it generally takes 16 to 20 days to ripen fruit harvested at the proper time and from 3 to 4 weeks if temperatures of about 55° are used. Storing the fruit at 32° previous to ripening shortens the time required for ripening at 60°, provided the storage period has not been too long.

The season at which the fruit is harvested has an influence upon the time required to ripen it. When harvested very early in the season, that is, when the fruit has attained approximately two-thirds its full size, it will require about 18 to 24 days to ripen at 60° F., and about 15 to 18 days when harvested 3 to 4 weeks later, or at the time when it is practically mature. It is very probable that soil and seasonal conditions also have some influence upon the length of the ripening period.

It is therefore not possible to predict exactly the time required to ripen different lots of fruit. The Magness and Taylor pressure tester greatly aids in determining when the fruit is in proper condition for use in canning or preserving and also in predicting the time it will require to ripen. Where large quantities of material are involved tests of the degree of softness should be made at intervals of 1 to 3 days throughout the ripening period. By noting the rate of softening at the beginning of the ripening process, it is possible to predict fairly closely the time when the fruit will be ready for use. A firmness of 3 to 4 pounds seems to be best for canning as well as for eating fresh. When the fruit is at optimum softness for eating fresh, as determined by biting into it, it is also ripe enough for canning.

HUMIDITY OF RIPENING AND STORAGE ROOMS

Air should be allowed to circulate around the fruit at all times during storage. Ventilating the room is generally not as difficult a problem as maintaining the proper humidity. The air should not be completely saturated but should be just sufficiently below the saturation point to keep the surface of the fruit dry or free from any condensed moisture. If the air is too dry the fruit will lose water and shrink or shrivel. The fruit may shrink or shrivel very rapidly at 80° to 90° F. if the air is very dry. Heavy losses from decay may occur if moisture condenses on the surface of the fruit. Generally a relative humidity of 85 to 90 percent is satisfactory.

SAFEGUARDING THE FRUIT AGAINST DECAY

When spores of rot fungi gain entrance to the tissues of the fruit they often destroy it quickly. One of the most serious difficulties in handling the fruit arises from its susceptibility to fungus attacks. The spores generally gain entrance through wounds; hence every precaution should be taken to prevent mechanical injury to the fruit and every sanitary precaution should be taken to exclude the spores of fungi from storage rooms. However, the amount of decay is greatly influenced by the ripening or storage temperature. Table 1 shows the results in one experiment. The maximum amount of

decay seems to occur at about 80° F. In some tests the decay was not quite so great at 90° or 100° as at 80°, although it was very great at these temperatures. For a period of 2 to 3 weeks the decay is generally not much greater at 60° than at lower temperatures. A ripening temperature of 60° has the double advantage of producing a maximum of softening and a minimum of decay.

ODORS IN STORAGE AND RIPENING ROOMS

The air of the storage and ripening rooms should be free from foreign odors and flavors. When stored in the same room with Kieffer pears certain vegetables give the pears an objectionable flavor. Potatoes especially give an "earthy" flavor to the fruit. It is probable that meats and many other foods would also impart objectionable flavors.

TABLE 1.—*Influence of ripening temperature on the development of decay in Kieffer pears after 17 days in the ripening room at different temperatures*

[Fruits grown at Lockport, N. Y.]

Temperature	Firmness (pressure)	Decay
	Pounds	*Percent*
80° F.	9.70	10.3
70° F.	6.82	6.6
60° F.	3.20	1.3

RIPENING FOR HOME USE

Although rooms with very accurately controlled temperature such as are available only in commercial practice are highly advantageous, it is not true that the home owner with a few trees cannot ripen the fruit satisfactorily. The Kieffer pear matures in September and October, when the weather is generally such that it is possible to secure the proper ripening temperature without artificial refrigeration. In almost any home, some room may be found which, with the exercise of a little judgment as to ventilation, can be converted into a ripening room that will be satisfactory. The temperature may vary between 55° and 65° F., and the fruit still will ripen satisfactorily. If the temperature of the outside air is too high during the middle of the day the windows or ventilators should be closed and then opened again at night, when the outside temperature is about 60° F. If the temperature tends to become too low at night usually a little ventilation during the day is sufficient to adjust the room temperature. Generally a clean cellar that may be readily ventilated will be most satisfactory.

COMPOSITION

Many characteristics of the Kieffer pear as a food product are directly dependent on its composition. Its usefulness for various purposes is determined to a considerable extent by the presence of certain constituents necessary to obtain the desired quality in the product. The changes that are so obvious in storage and ripening are the result of changes that occur in its chemical composition. Table 2 shows what changes may be expected in the composition of the

fresh fruit when harvested at different dates; table 3 includes those occurring when the fruit is ripened at different temperatures. The fruit is composed of about three times as much soluble as insoluble material. The soluble material consists of sugars, acids, tannins, and other constituents; the insoluble, principally of cellulose, lignin, and pectic substances. The sugars and acids very greatly affect the dessert quality of the fruit. The sugar content is relatively low, and the fruit often requires additional sugar to be of maximum quality as a table product.

TABLE 2.—*Firmness and composition of Kieffer pears when harvested on various dates. Grown at Beltsville, Md., 1932*

[Percentages expressed on fresh-weight basis]

Date of picking	Firmness	Solids soluble in alcohol	Solids insoluble in alcohol	Total solids	Total sugars	Total astringency	Titratable acidity	Protopectin	Soluble pectin
	Pounds pressure	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Sept. 16	14.5	12.16	4.76	16.92	5.76	0.053	0.245	0.45	0.30
Sept. 24	12.7	12.48	4.20	16.68	6.22	.094	.228	.46	.31
Oct. 4	13.0	13.00	3.86	16.86	6.84	.086	.235	.48	.31
Oct. 13	12.1	12.68	3.77	16.45	7.30	.092	.205	.54	.31
Oct. 25	12.0	12.92	3.23	16.15	6.90	.067	.208	.44	.29

TABLE 3.—*Firmness and chemical composition of Kieffer pears at time of harvesting and after 20 days' storage at various temperatures. Grown at Beltsville, Md., and harvested Oct. 25, 1932*

[Percentages expressed on fresh-weight basis]

Storage temperature (° F.)	Firmness	Solids soluble in alcohol	Solids insoluble in alcohol	Total solids	Total sugars	Titratable acidity	Total astringency	Protopectin	Soluble pectin
	Pounds pressure	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
No storage	12.0	12.92	3.23	16.15	6.90	0.208	0.067	0.44	0.28
40	11.1	12.60	3.38	15.98	7.05	.229	.096	.41	.31
50	6.5	11.92	3.29	15.21	6.69	.218	.095	.31	.41
60	4.0	11.56	3.23	14.79	6.74	.205	.075	.20	.64
70	7.1	11.14	3.50	14.64	6.63	.180	.087	.27	.31
80	10.6	12.26	3.50	15.76	7.15	.202	.095	.43	.31
90	11.2	13.04	3.72	16.76	7.25	.225	.113	.46	.28
100	13.0	15.16	3.86	19.02	7.79	.175	.106	.47	.37

The composition varies considerably from the skin to the core of the fruit. Just underneath the skin the sugars are rather high, and the amount decreases somewhat from the surface inward. The acid content is low in the tissues just underneath the skin and increases considerably from the surface inward. The flavor is also more pleasing in the tissues just beneath the skin. The tissues near the core contain a higher percentage of lignin as a result of the presence of the stone cells. Because of these characteristics the most desirable part of the fruit is that just underneath the skin.

The date of harvest does not seem to have much effect on the composition of the fruit. The soluble solids and sugars will be a little higher in the fruit harvested late in the season. During the ripening

process there is a rather marked change in the pectic substances of the fruit. The insoluble pectin, or protopectin, decreases during ripening, and the soluble pectin increases, thus allowing the individual cells in the fruit to separate more readily and therefore seeming to be softer. The total pectin content, although not great enough to make the fruit suitable for jelly making, is important because its presence increases the consistency of the product when made into preserves. It also accounts for certain physical characteristics of the product when prepared in different ways for the table. The conversion of protopectin into pectin during ripening seems to have a very great influence upon the character of the dried material, just as it does in the case of the canned product.

The food value of Kieffer pears compares very favorably with that of most other common fruits. The food constituents are almost wholly carbohydrates, the fat and protein are both rather low.

UTILIZATION

The usefulness of the Kieffer pear as a fresh product is dependent upon its proper ripening after harvest. The unripened fruit is crisp but hard, coarse, flavorless, and so inferior in palatability that it is almost worthless. The ripened fruit is agreeable in flavor, and much softer and smoother in texture than the unripened. If properly ripened, it is pleasing and palatable when eaten fresh. It may be combined with breakfast cereals as is customary with many other fruits. When properly prepared, it may be served alone or with sugar and cream. It may also be combined with other fruits in making salads and related dishes.

The unripened fruit does not soften during cooking to an agreeable texture, and is poor in flavor. The ripened fruit shrinks somewhat in cooking, and some of the juices escape, but it does not disintegrate or lose its shape. The sliced material may be cooked with the addition of sugar and served alone or in combination with other fruits.

Properly ripened fruit makes excellent pies. It is advisable to add to the fruit 4 or 6 percent of flour or starch, such as tapioca, to absorb the juices that escape in baking. Because of its greater thickening power about one-half as much starch is required as flour. Sugar should be added to suit the individual taste, which usually requires from 15 to 25 percent of the weight of the fruit. If desired, the pie may be flavored with nutmeg or cinnamon.

Properly ripened Kieffer pears are excellent when baked. For this purpose it is advisable to remove the peel as well as the core. The peel seems to impart a slight bitterness to the baked product. The fruit holds its shape well without the peel and does not collapse, as apples often do. In baking the whole fruit, sugar may be placed within the core cavity. This makes the fruit more pleasing to the taste of most individuals.

The usefulness of the fruit as a fresh product is curtailed by the fact that after ripening it cannot be kept in good condition for any extended period. The tissues soon break down physiologically and turn brown. Even when stored under refrigeration the fruit can only be kept for a very few weeks. For use for any extended period it must be preserved in some way.

CANNING

One of the most important uses of the Kieffer pear is for canning, which is done to a considerable extent commercially. A satisfactory product depends upon the proper ripening of the fruit. The unripened material when canned is hard, tough, and lacking in flavor; when properly ripened, it is agreeable in texture and pleasing in flavor.

Grading the fruit may be done either before or after ripening. In any case partly decayed and badly bruised fruits should be removed before ripening.

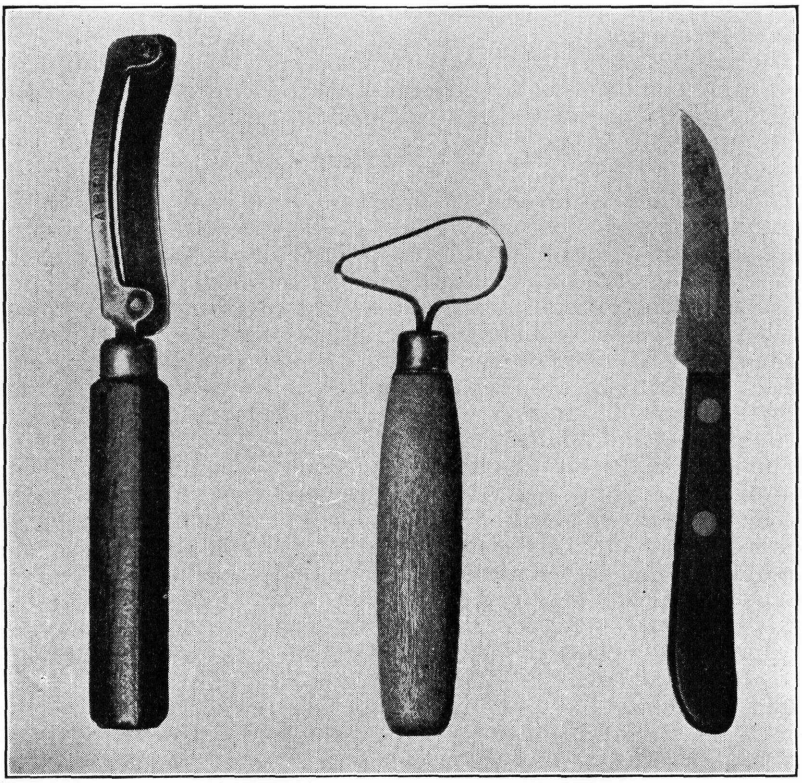

FIGURE 3.—Knives used in peeling and coring pears for canning.

After ripening, the fruit must first be peeled. By hand, this is very satisfactorily accomplished by using a special guarded knife. The coring is also facilitated by use of a special curved or looped knife (fig. 3). The peeling knife is recommended because not only is it more rapid, but it also removes the peel with much less waste than an ordinary knife. The sweetest and most delicious part of the pear is that just underneath the skin, and removing as little of this tissue as possible with the peel adds to the quality of the product. In removing the core it is advantageous to cut deep enough to include most of the tissues around the core that contain a large part of the objectionable stone cells. The calyx and stem are also removed in the coring operation. The waste in peeling and coring varies from 25 to 35 percent, depending upon the size of the fruit and its smooth-

ness. A machine has recently been perfected for peeling and coring pears, which is said to give a product much more uniform than can be produced by hand work. There is also some reduction in the waste that accompanies hand peeling and coring. The machine eliminates most of the hand labor, but it is adapted only to large-scale commercial operations. In commercial work the fruit may be peeled by means of superheated steam.

The peeled fruit turns brown rather rapidly when exposed to the air as a result of oxidations that are hastened by the presence of enzymes. To minimize this, it is best to submerge the fruit as soon as it is peeled in very cold water or a 1-percent salt solution, which retards the action while the fruit is being graded and packed.

The fruit is customarily canned as halves, but it may be sliced into quarters or eighths. This is sometimes more advantageous in home canning, especially if the fruit is to be used in making pies or garnishing salads.

The fruit should be packed in cans as quickly as possible after it is peeled. No. 2½ tin cans are most generally used in commercial canning, but no. 10 cans are preferred by hotels and large institutions. After the fruit has been placed in the cans, about 40- to 50-percent sirup should be added to fill the can but leave the proper head space. The cans should then be exhausted; for a no. 2½ can 3 to 4 minutes at 212° F. is generally sufficient. The cans are then sealed, processed at 212° F., and promptly cooled in cold water until there is just sufficient heat left to dry the exterior of the cans. Considerable care must be exercised to obtain the best product, for if the processing is continued too long or the cooling is not prompt a reddish-brown coloration that detracts greatly from the appearance of the product is likely to develop; if the processing is continued too short a time the material will spoil as a result of the growth of organisms. For no. 2½ cans 25 minutes at 212° is generally recommended.

For home canning either tin cans or glass jars may be used. For details of home-canning procedure the reader is referred to Farmers' Bulletin 1762, Home Canning of Fruits, Vegetables, and Meats.

PRESERVES

To secure satisfactory preserves, it is essential that the pears be properly ripened. The unripened fruit gives a product that is lacking in flavor, is tough, and is otherwise undesirable in texture. Fruit ripened to give a pressure test of 3 to 4 pounds or at the stage of ripeness that is best for eating fresh is satisfactory.

The fruit should be peeled and cored as for canning. The coring should be carefully done so as to remove the areas near the core which contain conspicuous clusters of stone cells, but with as little additional tissue as possible. After it is peeled, the fruit should be handled promptly to keep the tissues from browning. If it is to be held for more than a few minutes, it should be covered with ice water or a 1-percent salt solution.

It is generally best to slice the fruit into eight radial segments, although quarters or sixteenths may be used. Because the sugar penetrates into the fruit somewhat slowly, slicing into halves is not recommended.

The proportion of fruit to sugar is of considerable importance. The tartness, consistency, and flavor are greatly influenced by the amount

of added sugar. A mixture of 55 percent of fruit and 45 percent of sugar appears to be about right for most people. The Kieffer pear is rather low in acid, and the tartness of the finished product is increased by increasing the proportion of fruit in the mixture. The fruit is also somewhat low in pectin, and the consistency of the product is improved by increasing the amount of fruit. A proportion of 50 percent of fruit and 50 percent of sugar may be used, but the product is not quite acid enough and is somewhat sirupy in character. The sugar and fruit may be mixed before the material is heated. When the sugar is added, it immediately extracts water from the fruit, which may be sufficient in amount to permit boiling without the addition of water. However, as this tends to cause considerable shrinkage it may be advisable to add a little water and to heat the fruit slowly to the boiling point. The sugar is then added slowly and the fruit is constantly stirred. This method tends to lessen the shrinkage, and consequently to minimize the resulting increase in toughness.

In order to obtain the desired quality and consistency it is necessary to concentrate the material by heating it either in a vacuum or in the open air. A somewhat better product is obtained by carrying out the evaporation under reduced atmospheric pressure. Undesirable flavors are not so likely to be developed, and the delicate flavors of the fruit are better preserved. However, the concentration of the material may be satisfactorily carried out in an open kettle. It is advisable to apply the heat uniformly over the entire bottom of the kettle to prevent scorching. The boiling should be as rapid as is possible without scorching the material or causing it to overflow the sides of the kettle. It is generally better to cook the fruit in small quantities and to finish quickly, especially if the use of large quantities necessitates a longer cooking time. The longer the material is heated the more pronounced is the alteration in flavor. In home preserving it is generally advantageous to provide a kettle or evaporating pan of sufficient size so the material will not fill it more than 3 or 4 inches deep.

The factor that very largely determines the amount of evaporation is the consistency of the finished product. The consistency most desirable is one in which the sirup surrounding the fruit is thick enough to be conveniently spread upon bread. Preserves of proper consistency have 65 to 70 percent of solids and are generally obtained by evaporating water to the amount of 23 to 26 percent of the total weight of sugar and fruit combined or by boiling the material until the temperature rises to 224° to 226° F.

The yield of the finished product varies with the boiling temperature at the end and with the proportion of fruit to sugar. One hundred pounds of the fresh unpeeled fruit will yield 85 to 90 pounds of preserves when mixed with sugar in the proportion of 55 pounds of fruit to 45 pounds of sugar.

When the material has finished boiling it should be placed in sterilized containers of suitable size and sealed. If the containers are filled while still very hot, it is generally not necessary to heat further to prevent the growth of organisms unless the head space is excessively large.

DRYING

The Kieffer pear may be dried in the same manner as many other fruits. The advantages claimed for other fruits also hold for this pear. In order to produce a satisfactory product it is necessary to properly

ripen the fruit. There is a very striking difference between the products obtained from ripened and from unripened fruit, when dried according to the best procedure. That from unripened material is paler in color and more opaque than that from ripened fruit, and when refreshed and cooked it is tough and lacking in flavor. The product made from the ripened fruit is more desirable in texture, somewhat translucent, pale yellow in color, and appears to a certain extent as though it had been candied. When refreshed and cooked, it is tender and of good flavor.

Two methods of drying fruits are employed—artificial drying and sun-drying. The Kieffer pear matures late in the season, when the days are relatively short, the temperature low, and showers comparatively frequent. It therefore appears unlikely that sun-drying could be satisfactorily accomplished in any section of the country where the Kieffer is generally grown at present. In the East especially, where there are many cloudy days and the air is quite humid much of the time, equipment for drying the material artificially must be provided. Equipment that has been found satisfactory for apples, peaches, and apricots will serve for drying the pears. Equipment of this kind is described in Farmers' Bulletin 984, Farm and Home Drying of Fruits and Vegetables, and California Agricultural Experiment Station Bulletin 485, Drying Cut Fruits.

Peaches and Bartlett pears are sometimes dried without being peeled. The peel of the Kieffer pear is somewhat tough, and many stone cells are attached to it. The unpeeled fruit dries very much slower than the peeled, and much longer sulphuring is required to bleach the material. The quality of the unpeeled product is so inferior to the peeled that it appears decidedly inadvisable to dry unpeeled fruit. Peeling may be done in the same manner as described for canning and preserving (p. 10). The cores should be removed as in canning, for the fibrous material and the stone cells in the core are particularly objectionable in the dried product.

The fruit may be dried when sliced in nearly any manner if good drying conditions are available. It is customary to dry peaches and Bartlett pears sliced into halves. If the Kieffer pear is to be dried for market it would probably best be dried as halves. However, slicing into eight segments has many advantages; sulphuring is more quickly accomplished, the rate of drying is much more rapid, and the dry product is somewhat more rapidly refreshed. The eighths are as attractive as the halves, are even more easily prepared for the table, and are especially recommended in drying for home consumption.

In order to prevent the browning that occurs in most fruits dried without any treatment, it is customary after cutting, peeling, or other preparatory treatment to expose the fruit to the fumes of burning sulphur. This treatment is necessary with the Kieffer pear in order to give the material an attractive appearance. It is generally necessary to expose the halves to the fumes of sulphur dioxide for 4 hours. For fruit sliced into eighths 2 to 3 hours is generally sufficient.

Factors affecting the rate of drying are the same for Kieffer pears as for other fruits. The lower the relative humidity the faster the material dries and the drier it can be made. However, the air may have a rather high relative humidity and still be quite effective, especially in the early part of the drying process. In drying, the moisture evaporated escapes into the air, which must be removed

from the neighborhood of the fruit if the drying is to continue. For this purpose a current of dry air is passed over the material which has been placed on trays. This absorbs the moisture and removes it from the neighborhood of the fruit. If the velocity of the air current is too low the moisture is not effectively removed; on the other hand, an increase in velocity above a certain rate is of comparatively little additional value. The best velocity varies with the amount of fruit on the trays and their arrangement, but is generally between 3 and 6 miles per hour, or 264 to 528 feet per minute.

Heat is required to evaporate the moisture from the material and is generally conducted to the fruit in the circulating air; consequently, the air serves the double purpose of carrying the heat to the material and removing the evaporated moisture. The higher the air temperature the greater the amount of heat that is conducted to the material and the faster the drying; but if too high a temperature is used, the flavor and natural shape are altered. The best temperature varies somewhat with different conditions but should be such that the temperature of the product itself will not rise above 140° or 145° F. With most types of drying apparatus this will mean that the temperature of the incoming air should not be greater than 160° to 165° at any time. In driers not having large air inlets and outlets it is necessary to keep the temperature of the incoming air somewhat lower than this, as the temperature which it is safe to use depends to a very large degree on the rate of air movement. If there is a rapid flow of air through the drier, the moisture evaporated from the material is promptly carried away, the humidity of the air surrounding the material is low, the heat supplied is expended in converting liquid water into vapor, and the fruit remains at a temperature much below that of the air because it is kept cool by evaporation. If air movement through the drier is slow or the outlets are too small to permit its ready escape, the humidity of the air inside the drier increases until the air can absorb no more moisture. As the heat supplied cannot be expended in vaporizing water, the material becomes heated to the temperature of the surrounding air. Under such circumstances the fruit, instead of drying, undergoes a process of stewing in its own juices which injures its appearance and texture and is especially injurious to the flavor.

Many small driers have totally inadequate air outlets, so that it is almost impossible to operate them without partially cooking the fruit. Such a result can be avoided by providing the drier with larger outlets and inlets so that slow movement and consequent saturation of the air cannot occur. Very good results can be obtained in drying with very simple equipment if the operator has a clear understanding of the fundamental principle, that is, that drying depends upon a free flow of air over and through the material and that the amount of heat supplied must be so regulated in relation to the amount of air passing through the drier that the heat used is expended in vaporizing the water and not in warming the material.

After being dried, the material should be protected against atmospheric changes and insect attack. When exposed to moist air, it readily absorbs water. The water-absorbing capacity varies with the humidity of the air to which it is exposed; in saturated air the fruit may absorb an equal weight of water. However, the material deteriorates rapidly if allowed to absorb large amounts. It will keep

fairly satisfactorily for several months with 10 to 15 percent of moisture; if it is to be stored for a longer period, the moisture content should be reduced to below 10 percent. The material will keep almost unchanged indefinitely if it is made completely dry. Any type of container may be used for storage provided it excludes the moist air and prevents the access of insects to the material.

Dried Kieffer pears may be used in the same way as most other dried fruits. They may be stewed in the same manner as peaches or prunes, in which case it is advantageous to add sugar in order to secure the best quality in the product. The material makes an excellent pie when soaked in enough water to make the moisture content 70 percent with the addition of sufficient sugar to give the proper acid-sugar balance, which usually requires the addition of 15 to 25 percent of the weight of the refreshed fruit.

PICKLING

Kieffer pears are frequently used for making sweet pickles. Partially ripened or fully matured unripened fruit may be used, but the product made from properly ripened fruit appears superior in texture and flavor. The fruit should be peeled and cored as for canning. It may be sliced into halves, quarters, or eighths, but the last size is generally preferred. Most of the recipes given for making sweet pickles from pears in general will also be satisfactory for Kieffer pears.

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